

Status of the analysis of charged pion events in the TPC for the measurement of the total cross section (π^\pm , Ar)

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Animesh, Tapasi, Celio, Jae Yu and many thanks to Ryan.

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Outline

1. Selected data for analysis
2. Reconstruction chain and selections
3. Analysis: actual results and issues
4. Next steps for data analysis
5. MC studies in lariatsoft framework

See lartpc-docdb: LARTPC-doc-1564-v1, LARTPC-doc-1608-v1

Selected data for analysis

π^- Analysis:

- ▶ 60 A Negative polarity:
Runs 6100, 6101, 6102, 6102, 6103, 6104, 6105, 6110, 6111,
6112, 6116, 6245
- ▶ 100 A Negative polarity:
Run 6326

\approx 6000 spills with an average of 20 events/spill

Need to process reconstruction and analysis on more 100 A Runs

Reconstruction chain and selections

- ▶ Runs processed with the newest version of Slicer
- ▶ First filter - Trigger Filter: BEAMON and NO PILEUP
- ▶ Beamline reconstruction: WC tracks, ToF, PID
- ▶ TPC reconstruction: track reconstruction and calorimetric information
- ▶ Second filter: TPC Primary selection (and PiMu Filter)
- ▶ TPC & Beamline tracks matching

Reconstruction chain and selections

TPC Primary selection Filter:

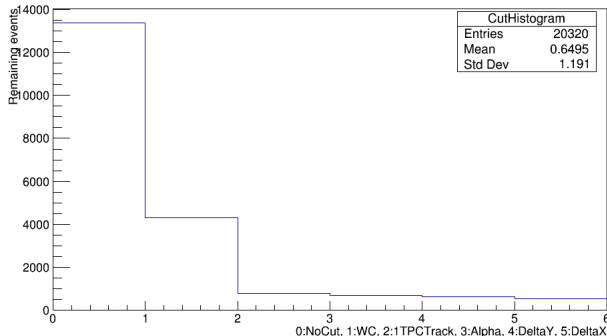
- ▶ First Upstream z_{cut} , the track must have a space point within 2 cm in Z of the upstream face \rightarrow we're looking at primary from the beam
- ▶ Second Upstream z_{cut} , there must be only 1 track with a space point within 10 cm in Z of the upstream face of the TPC \rightarrow reinforce the “no PILEUP” rule, filter out showers from beam electrons
- ▶ Track Matching cuts:
 - α (angle between the WCTrack and the TPC Track direction vectors at the US face) $< 20^\circ$,
 - ΔY at US TPC Face = (TPCTrack Y - WCTrackY) = [-3, +8] cm,
 - Added ΔX at US TPC Face = (TPCTrack X - WCTrackX) = [0, +6] cm

Reconstruction chain and selections

Quality plots:

Cut histograms after Trigger Filter and TPC Filter

Number of events left after each cut



→ WCTrack Builder \approx 30% efficiency on triggered events,
improvements to Track Matching cuts (lately use new Track
Matching module)

Analysis: actual results and issues

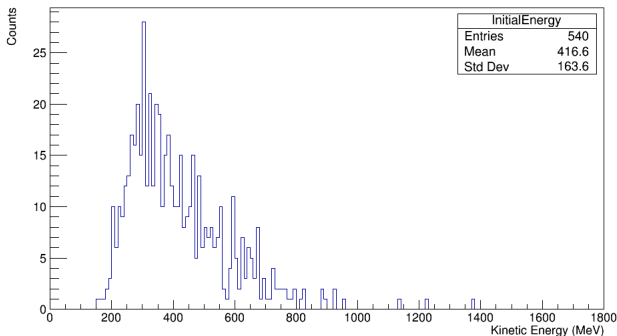
- ▶ Updated the producer module for pion XS evaluation in lariatsoft (developed by Ryan):
 - added calorimetric information,
 - closest tracks matching,
 - **preliminary** selections for stopping particles and crossing particles
- ▶ Next step: make and outstanding analysis macro reading the track info after the AnaTree

Analysis: actual results and issues

Quality plots:

Incident energy distribution at TPC (assuming all Pions for momentum to energy conversion from WC tracks and $E_{dep}=8$ MeV in death layer from Beam Window to LArTPC sensitive area)

Initial Kinetic Energy of Particle in TPC

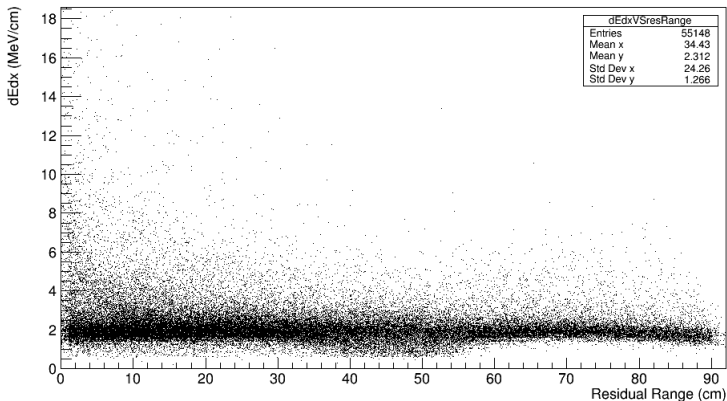


Analysis: actual results and issues

Quality plots from TPC tracks calorimetry:

Specific energy loss vs Residual range for selected TPC tracks

dEdx vs ResRange for the selected tpc tracks



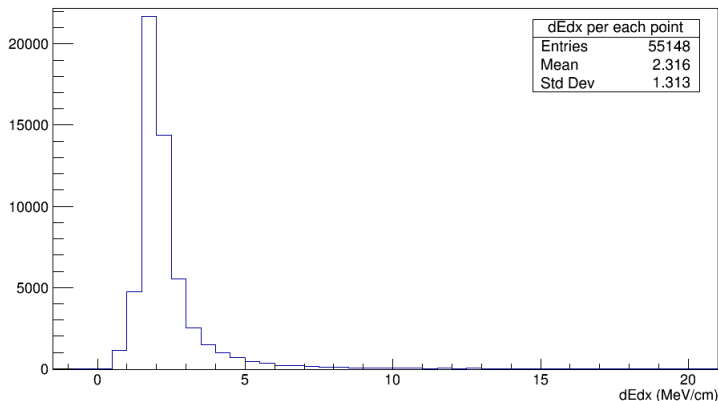
→ PMT effects

Analysis: actual results and issues

Quality plots from TPC tracks calorimetry:

Specific energy loss for each calo hit in selected track

dEdx per each point on TPC tracks

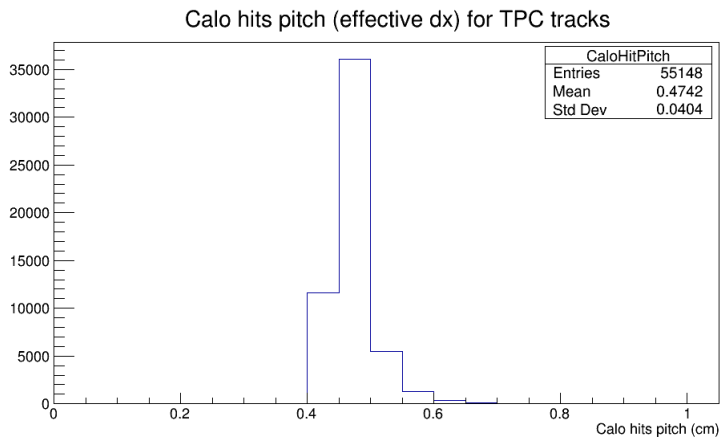


→ Fit gaussian and landau convolution → MPV $\simeq 2.1$ MeV/cm
(pions as MIPs)

Analysis: actual results and issues

Quality plots from TPC tracks calorimetry:

Calorimetry hit pitch distribution



→ Avg calo hit pitch = 0.4725 cm

Analysis: actual results and issues

Total (π^\pm , Ar) cross section goal

“Many thin slabs method” for total (π^\pm , Ar) cross section measurement

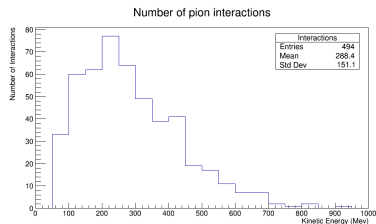
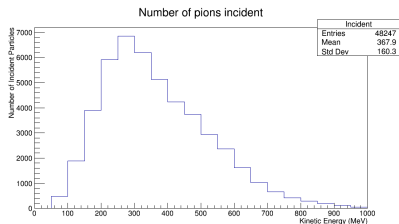
$$\sigma(E) = \frac{N_{int}(E)}{N_{inc}(E)} \frac{1}{Ndx}$$

N density of scatter centers in the target, dx fixed target thickness (assumed thin target)

→ The slabs follow the track trajectory: slab width $dx = 4.725$ mm (avg calo hit pitch distrib)

Analysis: actual results and issues

“Many thin slabs method” for Total (π^\pm , Ar) cross section measurement

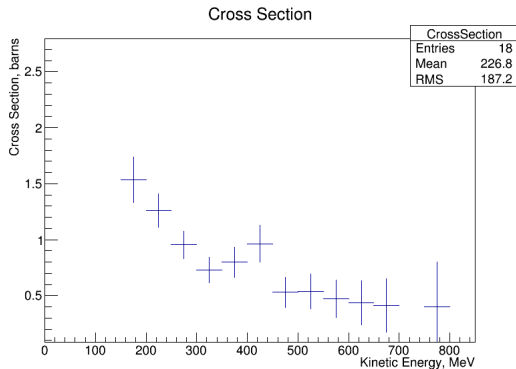


Stopping particles: $E_{end} < 50$ MeV \rightarrow all the track is not considered for analysis

Crossing particles: if last SpacePoint has $z > 89$ cm \rightarrow the last two points of the track are not considered for analysis

Analysis: actual results and issues

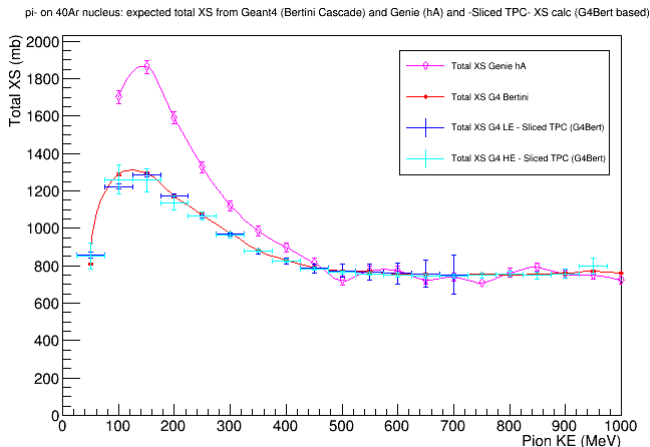
Measured π total cross section plot (ONLY from 10 Runs)



The job on all the selected runs is actually in process

Analysis: actual results and issues

How does the measured XS compare with Geant4 prediction?
Geant4 XS prediction (MC simulation at particle level)



Next steps for data analysis

- ▶ Reco and analysis on more runs at 100 A
- ▶ Selection cut to get rid of em showers
- ▶ Improve calorimetry selection criteria for stopping and crossing particles
- ▶ Filter based on Optical Alg for hits from ETL PMT (beamon - beam particles check, michel electrons - decay in flight)
- ▶ Pion filter from AuxDetParticleID (actually PiMu Filter)
- ▶ Uncertainties on xs evaluation, especially systematic errors (Elastic scattering min angle,.....)

MC studies in lariatsoft framework

Main goal: compare with data results to evaluate systematic errors

Status:

- ▶ Monochromatic pions in TPC produced and reconstructed → tracks need to be analyzed with “Many thin slabs method”, the analysis code need to be readapted
- ▶ Simulation with G4Beamline → TPC tracks and WC tracks to be reconstructed and processed with analysis